DOCUMENT RESUME

ED 260 934 SE 045 974

AUTHOR Donovan, Edward P.; And Others
TITLE Eighth Grade Science Teachers as Sex-Role Models for Eighth Grade Girls' Science and Engineering Career Interests.
PUB DATE 5 Oct 84
NOTE 24p.; Paper presented at the Annual Meeting of the Northern Rocky Mountain Educational Research Association (2nd, Jackson Hole, WY, October 4-6, 1984). For the dissertation on which this paper is based, see SE 045 975.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Engineering; *Females; Grade 8; Junior High Schools; *Role Models; *Science Careers; Science Education; Science Instruction; *Science Interests; Science Teachers; *Secondary School Science; Sex Differences; *Sex Role; Teacher Effectiveness
IDENTIFIERS Science Education Research

ABSTRACT

This study investigated the potential influence of female science teachers as sex role models for eighth-grade girls' science and engineering (SE) career interests. Subjects were 30 eighth-grade science teachers (14 men and 16 women) and their 1,937 eighth-grade students (992 girls and 945 boys). Using an SE career interest survey (CIS) developed by the authors, all students were surveyed at the beginning and end of the eighth-grade school year. Statistical analyses used to test interaction of teacher and student sex on student SE career interest show: (1) that the interaction did not account for a significant amount of the variance of student SE career interest; (2) a statistically significant correlation between CIS pre- and post-survey scores for the students; (3) a statistically significant correlation between student sex and the CIS scores (indicating that boys scored higher than girls); and (4) that teacher's sex did not account for a statistically significant amount of the variance of the girls' CIS postsurvey scores. These results indicate: (1) that as sex role models, the teachers did not enhance the SE career interests of their students; and (2) that the girls' SE career interests were not influenced by the sex of their teacher. (Author/JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

BEST COPY AVAILABLE

5.2

ED260934

Eighth Grade Science Teachers as Sex-role Models for Eighth Grade Girls' Science and Engineering Career Interests*

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
* Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Presented:

Northern Rocky Mountain Educational Research Association
1984 Meeting
Jackson, Wyoming
October 5, 1984

Edward P. Donovan
University of Colorado at Colorado Springs

Robert H. Fronk and Phillip B. Horton
Florida Institute of Technology

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Edward P. Donovan
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

*Donovan, E. P. The influence of the eighth grade science teacher's gender, classroom laboratory emphasis, level of understanding of science and career interest on eighth grade girls' science and engineering career interests. (Doctoral dissertation, Florida institute of technology, 1982). Dissertation Abstracts International, 43/03, 746-A. (University Microfilms No. 82-189, 78)

SE045974

Running head: Eighth Grade Science Teachers

BEST COPY AVAILABLE

Abstract

It has been postulated by a number of researchers, that one of the important factors relating to the small number of women employed in science and engineering careers (S/E) is the small number of women teaching science at the secondary school level. Because of the small number of women secondary school science teachers, it is thought that girls do not have the necessary role models needed to influence their S/E career interests.

The purpose of this study was to investigate the potential influence of women science teachers as sex-role models for eighth grade girls S/E career interests. The study involved 30 eighth grade science teachers (14 men, 16 women) and their 1937 eighth grade students (992 girls; 945 boys).

Using a S/E career interest survey developed by the authors, all students were presurveyed at the beginning of their eighth grade year and then postsurveyed close to the end of that school year. A 2x2 ANOVA using multiple linear regression analysis as the statistical method was used to test the interaction of teacher and student sex on student S/E career interest. It was found that the interaction did not account for a significant amount of the variance of student S/E career interests ($F = .00$, $p > .05$). A statistically significant correlation was found between the CIS pre- and postsurvey scores for the students ($r = .78$, $p < .05$). Also, a correlation between student sex and the CIS scores was statistically significant ($r = .28$, $p < .05$), indicating that the boys scored higher than the girls on the CIS. It was also determined that the teacher's sex did not account for a statistically significant amount of the variance of the girl's CIS postsurvey scores.

The two major conclusions reached in this study were: (a) as sex-role models, the eighth grade science teachers were not found to enhance the S/E career interests of their students, and (b) that eighth grade girls S/E career interests, as measured in this study, were not influenced by the sex of their teacher.

Introduction

A problem that has been evident in the United States for many years is the low number of women employed in science and engineering careers. According to the 1977 National Science Foundation study titled "Women and Minorities in Science and Engineering," about 96,000 women were employed as scientists and engineers in 1974. This seems like a sizeable number until it is also stated that these women represented only 6% of the 1.7 million employed scientists and engineers in the United States in 1974. In a more recent study done between 1976 and 1978 by the National Science Foundation, it was shown that the employment rate of female scientists and engineers has increased significantly faster than that of men. Women employed in science and engineering (S/E) increased from the 1974 figure of 6% to 8.3% in 1976 and then to 9.4% in 1978. This still means that 90.6% of the scientists and engineers in 1978 were men. It should be noted that even if the present growth rates of women in S/E remain the same over the next 20 years, women would still represent only 28% of the total employed in S/E in 1998 (Kornberg, 1980).

Why women are so underrepresented in S/E professions has become a major area of investigation over the past 10 years. The low number of employed women in S/E careers probably involves many factors, such as work values, inadequate elementary and secondary science and mathematics preparation, sex-role stereotyping, insufficient female role models, strong family obligations, parent occupational influence, salary and other economic inequities, outright discrimination, and insufficient career education. Researchers involved in womens' career education have placed their primary emphasis on studying how female role models employed in S/E influence girls through special career programs (Lantz & West, 1977). Unfortunately, these role models are only there for a short time and, except in one study by Weiss, Place, and Conway (1978), their effect has not been shown to be statistically significant.

One science teacher characteristic that may affect the S/E career interests of secondary school girls is the teacher's gender. This science teacher characteristic has not been thoroughly explored in the research literature. In this study, the teacher as a sex-role model for male and female student S/E career interests was investigated.

The Science Teacher as a Sex-Role Model

Kemper (1968) has defined a role model as a comparison group (or individual) which demonstrates to the individual how something is done. O'Leary (1974), has stated a more detailed definition of a role model. This definition is as follows:

> The essential quality of the role model is that he (or she) possesses skills and displays techniques which the actor lacks (or thinks she lacks) and from which, by observation and comparison with his or her own performance, the actor can learn. Hence, in order for achievement to occur, the actor needs a role model to emulate. (p. 818)

O'Leary has suggested that the lack of female role models who have successfully combined marriage and family with a successful occupation has acted as a barrier to the occupational aspirations of women in general. Joesting and Joesting (1972) suggested that having qualified female role models could enhance the self-image of women students. With a positive self-image, more women might pursue masculine-related positions (Shein, 1972).

Numerous researchers have stated that the role of teachers in influencing girls' career interests is very important (Button & Brown, 1980; LaFitte, 1974; Malcom, Hall & Brown, 1976; O'Leary, 1974; Tidball, cited in "Women in Science", 1975; Trotter, 1976).

Sears and Feldman (1966) have suggested that parents start the process of teaching "sex roles" and that teachers continue this process when the child enters school.

In a 1977 NSF study of Science Education in the United States, Weiss (cited in Buccino, 1980) reported that there was a large difference in the percent of male and female teachers teaching science at different grade levels. Weiss found that at grades K-3, 98% of the teachers teaching science were women (n = 838), at grades 4-6, 67% of science teachers were women (n = 829), at grades 7-9, 38% of the science teachers were women (n = 1538), and finally at grades 10-12 only 24% of the science teachers were women (n = 1624). It is interesting to note that the percent of women teaching science decreases drastically at higher grade levels, with this same trend continuing into the university level. It should also be pointed out that during grades K-3 (n = 467), only 17 minutes per day were spent dealing with science, and at grades 4-6 (n = 302) this value increased to 28 minutes per day. Therefore, at the time when girls receive their maximum amount of science instruction (grades 7-9), only 38% of the science teachers are women. When the number of women teaching science is greatest, in grades K-6, the least amount of time is spent on science as compared to other subjects.

Grades 7-9 are generally considered a primary time when students are faced with making major decisions in their preparation for the future. This is also the time when most students have their last encounter with science. Therefore, the absence of female role models for S/E careers may be an important factor for young girls. The absence of female role models may be even more serious at the high school level. In grades 10-12, girls drop out of college preparatory courses earlier than boys and usually take less science (Remick and Miller, 1977).

In a 1981 study by Wright and Hounshell involving the science interests of 150 outstanding high school students participating in the North Carolina Junior Science and Humanities Symposium, it was found that the boys' interest in science was significantly higher than the girls' interest. Seventy-four percent of the students responding to a questionnaire stated that their interest in science developed through school related activities, with the largest percent (35%) reporting their interest developed in grades 7-9. It was also found that school was significantly more influential for female students than for male students. Students rated teachers in grades 10-12 as the most influential factors in developing their interest in science, and junior high teachers were rated as second in importance. This study highlighted the importance of the teachers' role in stimulating students' interest in science.

Similar results were reported in an earlier study by Koelsche (1965). This study involved 54 award winning students attending the Junior Academy of Sciences in Georgia. The two major conclusions reached in this study were: (a) girls tend to become interested in biological science and boys in physical science, and (b) that the teacher holds the key to superior achievement and interest in his/her students (Koelsche, 1965).

In a study of 10 female and 11 male elementary school teachers and their 734 students in grades 5 and 6, Lindsay (1973) reported that the teacher's sex was not a significant factor in science interest as measured by a questionnaire.

Hardin and Dede (1973) reported that interest inventories generally show no significant differences between girls and boys in seventh grade in reference to preferences for science, but significant differences do appear after eighth and ninth grades. At this time girls' interests in science decrease. In their study, Hardin and Dede concluded that one of the major ways to actively counteract sexism in science careers and promote women to greater interest in science careers is by recruiting more women science teachers in secondary schools.

Maccoby and Wilson (1957) found that students at the seventh grade level generally retained more information when influenced by a model of the same sex than by one of the opposite sex. In another study involving 10 female and 28 male general science teachers, Reed (1961) found that the sex of the teacher did not significantly affect the interest in science of their 1036 students. Interest in science was measured in a 70-item scale of the pupil's voluntary activities in science during the school year.

In the two most recent studies dealing with secondary school science teachers as sex-role models, Stake and Granger (1978) and Vockell and Lobonc (1981) have reported conflicting results. The study by Stake and Granger (1978) included a sample of 129 boys and 141 girls from senior high schools in Missouri. The teachers initially agreeing to be involved in the study consisted of 10 male and 10 female science teachers who had worked with these students on original science research projects. The authors reported that only 14 of these teachers returned the questionnaire needed for the study. It should be mentioned that the teachers were volunteers. Therefore, they might not be representative of other science teachers. Using a Science Career Attitude Survey (SCAS) they had created, Stake and Granger looked at the interaction of the sex of the teacher and the sex of the student on students' science career interest. The SCAS sections used in the study included measures of: (a) the sex of the teacher model, (b) the perceived attractiveness of the teacher model, (c) the amount of science-related contact between the student and teacher model, and (d) the student's commitment to a science career. Stake and Granger stated that "To determine the students' commitment to a science career, students were asked, 'To what extent would you like to have a career in science?' Students indicated the strength of their commitment on a 7-point scale" (p. 182). In the analysis of the interaction of the sex of the teacher and the sex of the student, the results were reported as statistically significant ($p < .02$). It was also reported that girls with female teacher models and boys with male teacher models had statistically higher science career commitment

scores than girls with male teacher models and boys with female teacher models. Stake and Granger (1978) concluded that students who have had same-sex teacher models had a greater science career commitment than those students with opposite-sex teacher models. It was emphasized that the strength of the students' feelings about wanting to be like their model also made a difference.

Another conclusion reached by Stake and Granger was that the more contact time the students had with their model, the greater commitment the students had to science careers. It was suggested that since the number of female science teachers at the high school level was so small (23% in this study), that the absence of female science teacher role-models may be an important factor that discourages girls from pursuing science careers. Stake and Granger suggested that an affirmative action program might be necessary to change the nonparticipation of women in science careers. Because Stake and Granger did not report validity and reliability data for their Science Career Attitude Survey and because of the small number of teachers involved in their study (n = 14), their results have questionable validity and reliability.

In a study involving 1035 high school students, Vockell and Lobonc (1981) reported somewhat different conclusions. They predicted that, if sex-role modeling was important, schools with all female physical science teachers would display "more feminine ratings" toward science career fields than those with all male teachers. Feminine and masculine ratings were determined by giving the students a questionnaire which required them to rate 45 career fields related to a variety of academic disciplines. Each career field was rated as to the perceived degree of masculinity or femininity on a seven point scale. Vockell and Lobonc found no significant difference in the attitude of girls with all female science teachers and those with all male science teachers. It should be noted that this study did not look at career interest but whether the girls felt that a career field was masculine or feminine; therefore the conclusions are questionable for application to interest in science careers.

At the college level, Weishaar, Green, and Craighead (1981) reviewed the influences that affect the vocational choices of 18 women. Forty five percent of the women identified "no one" as a primary influencer of their vocational choice. Other influences which were identified were 13.3% father, 12.3% high school teacher, and 7.9% mother. In reports of same-sex influencers, approximately 86% of male students reported they were influenced by men and of the female students, 58% reported they were influenced by men, while 38% were influenced by women. It was noted that a statistically significant number ($p < .01$) of the female students reported being influenced by women in their career choice. Weishaar, Green and Craighead's findings support the conclusion of other researchers (Bray & Howard, 1980; Brown, 1979; LaFitte, 1974; O'Leary, 1974).

In a review of twelve National Science Foundation programs funded to study the reasons for the small number of women in S/E careers, Lantz and West (1977) concluded that longer contact periods between female role-models and female students should be used. They also stated that the effect of school personnel on female career interest should be investigated, since teachers and guidance counselors have the potential for long-term and direct influences.

There was a definite need for more research into the effects of the sex of science teachers on student career interest in science and engineering. This is especially true for girls at the junior high level.

Hypotheses

Research Hypothesis

There will be a statistically significant positive correlation between the S/E career interest postsurvey scores of eighth grade girls and boys and the gender of their eighth grade science teacher. Therefore, girls with a female science teacher and boys with a male science teacher will have higher S/E career interest than girls with a male science teacher and boys with a female science teacher.

Null Hypothesis

No variance in the S/E career interest postsurvey scores, as measured by the CIS (a science and engineering career interest survey), of eighth grade girls and boys will be accounted for by the interaction of the gender of the eighth grade students and the gender of their eighth grade science teacher.

Research Design

The two major purposes of this study were: (a) to determine whether the interaction of the sex of the eighth grade science teacher and the sex of their eighth grade students was related to the S/E career interests of the eighth grade students, and (b) to determine if women science teachers act as sex-role models for the S/E career interests of their female eighth grade students.

The study included one dependent variable, which was the S/E career interest postsurvey scores of the science teacher's students, and four independent variables. These independent variables included: student CIS presurvey scores, student sex, teacher sex, and the interaction variable (student and teacher sex).

This research study employed a non-equivalent, control group design which involved the use of a presurvey and a postsurvey.

Population and Sample

The population for this study was the eighth grade science teachers employed in the state of Florida during the 1981-82 school year and their eighth grade students.

The sample included 30 eighth grade science teachers (14 men; 16 women), who volunteered to be involved in this study and who were employed in eleven public middle and junior high schools and one K-8 parochial school located in Brevard and Indian River Counties, Florida. The sample did not include four public middle and junior high schools, and a few of parochial schools also located in the two counties. For this proposed study, four of the public schools did not choose to participate and the other parochial schools were not asked to participate. The sample also included 1937 eighth grade students (992 girls and 945 boys) attending these schools. These

1937 students included only those students that were present in the same science teachers classroom for both the presurvey and the postsurvey.

Brevard and Indian River Counties are located on the east-central coast of Florida. The counties are approximately 60-90 miles east of Orlando, the nearest major metropolitan area. Brevard County consists of numerous small cities such as Titusville in the north, Cocoa, Cocoa Beach, and Merritt Island in the central area, and Melbourne in the south. The major city in Indian River County is Vero Beach. The Kennedy Space Center, Cape Canaveral, and Harris, Inc., a major industrial firm are also located in these counties. The counties contain Florida Institute of Technology, Brevard and Indian River Community Colleges, and branches of Rollins College and the University of Central Florida. The area is mainly suburban and growing in adult population.

Eighth grade girls and their teachers were chosen to be the subjects in this study for three reasons:

1. All eighth grade students usually take science, therefore enabling a larger sample of teachers and students to be gathered (Murray, Note 1).

2. Middle/Junior high school is the time for students to choose their high school programs and whether they will elect to take more science. Since after junior high school only one year of high school science is required in these counties, eighth grade may be a critical time for initial career decisions (Murray, Note 2).

3. By eighth and ninth grades, many students in the two counties may have considerably limited their future career choices (Schmidt, Note 3).

Data Procurement

This research study involved a presurvey and postsurvey. All of the eighth grade students were presurveyed to measure their career interest in S/E at the beginning of the year (during the first week of September, 1981). The presurvey was the Career Interest Survey (CIS) that was developed by the authors to measure the students' initial science and engineering career interest before any influence of the new science teacher occurred. The CIS was administered by each eighth grade science teacher following a standardized test administration procedure. By using a presurvey, the authors were able to statistically control for the initial differences of each science teacher's students. For each science student, the postsurvey score on the CIS was the dependent variable of the study. The postsurvey was administered at the end of the school year (during the first week of April, 1982).

Data Treatment

In the testing of the null hypothesis, a 2 X 2 ANOVA using multiple linear regression analysis was used, following the procedures described by Cohen & Cohen (1975). The null hypothesis to be tested involved the interaction of the sex of the science teacher sex and the sex of the student with the S/E career interests of the science students.

The information obtained for each teacher and his/her students

are summarized below. Abbreviations for each of the variables used in the study are also given. These abbreviations are referred to later in this work.

CISPOST, the dependent variable, was the score on the CIS of the eighth grade students who were present during the postsurveying in April of 1982. The total number of questions in the CIS was 56. The last six questions of the CIS were used for determining concurrent validity of the CIS. The maximum score for career interest in S/E for any individual student is 50. The raw score was used in this study. Scoring of the survey was done with a machine scorer at Florida Institute of Technology.

The following independent variables were utilized:

CISPRE - This was the score on the CIS of the eighth grade students present in the science classes during the presurvey in September, 1981. The maximum score was 50 for a student, as in the postsurvey. The purpose of this variable was to control statistically for initial differences in S/E career interest between the students of each science teacher.

TSEX - This was the sex of the teacher. For the analysis of the null hypothesis, a female teacher was entered as .5, while a male teacher was entered as -.5.

SSEX - This is the sex of the student. For null hypothesis one, girls were entered as .5 and boys as -.5.

INTSEX - This is the interaction variable which includes the teacher's sex (TSEX) x the student's sex (SSEX). This variable is calculated by the computer in the interaction analysis.

The null hypothesis was tested by using multiple linear regression analysis. SPSS (Statistical Package for the Social Sciences) was used for the data analyses (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975). A 2 X 2 ANOVA was carried out using the VAX/VMS computer at the Interactive Computer Facilities of Florida Institute of Technology.

By using multiple linear regression analysis, it was possible to determine how much of the variance in the dependent variable was accounted for by each independent variable, and the interaction variable.

All tests of significance were performed at the .05 level. The probability of rejecting the null hypothesis, if, in fact, they should be rejected, was calculated using the procedures of Cohen and Cohen (1975). The power to detect various effect sizes such as .02, .13, and .25 (as R-squared) for the hypothesis with a sample size of n = 60 and alpha at .05 are .12, .62, and .95, respectively. These power values indicate the probability of detecting statistically significant departures from the null hypothesis as large as the effect size (ES) indicated. These values indicate that a test has a greater than 95% chance of detecting significant departures from the null hypothesis as large as R-squared = .25, while there is less than 12% chance of detecting differences as small as R-squared = .02 at an alpha level of .05.

Following the procedures given by Cohen & Cohen (1975) the ordering of the independent variables for the 2 X 2 ANOVA using multiple linear regression analysis was CISPRE, followed by TSEX, SSEX, and finally INTSEX.

Instrument used

CIS - A S/E Career Interest Survey

The Career Interest Survey (CIS) Form B was used in this study to measure the science and engineering (S/E) career interest of the eighth grade boys and girls.

Student career interest in science and engineering (S/E) is usually measured as one aspect of a standardized test in which career interests in selected occupational groups are measured. Some of the most popular career interest tests for the secondary school level include the Kuder General Interest Survey, Form E (Kuder, 1976), Planning Career Goals Interest Inventory (American Institutes for Research, 1975), the Self Directed Search (SDS), Form E (Holland, 1979), and the JOB-O (Cutler, Ferry, Kauk, & Robinett, 1980). Many of these tests give separate scores for the different sciences, and they do not consider the teaching of science as a science career. Because of this separation of the different areas, the overall interest in S/E for a student can not be determined. For this study, the problems in getting one score measuring the overall S/E career interest of students led the authors to develop the Career Interest Survey (CIS). In the CIS, a S/E career is characterized by requiring the completion of at least a four year college program with a major in science, science education or engineering. The CIS S/E interest score includes a measure of interest in all occupations of S/E, such as engineering, the medical related fields, behavioral sciences, biological and physical sciences, architecture, elementary through college level science teaching, and many other related fields.

The CIS was developed and field tested during the summer of 1981. This survey was developed to measure the overall S/E career interests of seventh through ninth grade students.

CIS Form B contains four major parts with a total of 56 questions. The entire survey, except for question #56, is set up using multiple forced-choice questions with three to five possible answers, depending on the part of the CIS. Only question #56 is different since it asks the student to write his/her actual job interest on the answer sheet.

In Part I (30 questions), students are expected to select from occupational activities, while in Part II (20 questions) they are to select from various occupations. Part III (5 questions) and Part IV together make up the CIS internal verification scale.

The CIS test-retest reliability coefficients for one week and eight months were calculated as .96 (n=57, grades 7-9) and .78 (n=1937, grade 8), respectively. The KR-21 estimate for the CIS was calculated as .92. Criterion-related validity coefficients were calculated in two ways: (a) CIS scores were correlated with the Kuder GIS science subscale (r=.75, n=45, grades 7-9), and (b) CIS scores were correlated with a CIS internal verification scale (r=.59, n=127, grades 7-9). Evidence to support the construct validity of the CIS was collected by two methods: (a) for 7-9 grade students (n=45), the CIS score was found to correlate .75 with the scientific subscale and -.42 with the artistic subscale, of the Kuder GIS. (b) the second method compared the scores of known

groups. Test results for students in grades 7-9 (n=127; n=1937) showed a statistically significant difference between the scores of boys and girls on S/E career interest. The readability of the CIS was determined to be at the seventh grade level.

General Results and Comments

It was found that, in the schools involved, students frequently move in and out of the area. Because of the transient nature of the student sample, only those students that took both the pretest and posttest with the same science teacher were used in the analyses. Table 1 lists the mean pre- and postsurvey scores for boys and girls for each teacher but, more importantly, indicates that there were significant differences in the number of eighth grade students for each teacher. Therefore, in the statistical analysis for all of the null hypotheses, each student was entered into the regression analyses as a separate case to correct for the different number of students of each teacher. Consequently, a weighting factor was used to correct for these differences by using the number of teachers (30) to determine the degrees of freedom, instead of the number of students (1937), since this was primarily a teacher study.

Insert Table 1 about here

Table 2 displays the means, standard deviations and N for the pre- and postsurvey CIS scores for all students, for girls only and for boys only.

Insert Table 2 about here

Results of Interaction Analysis

A 2 X 2 ANOVA using multiple linear regression analysis was performed to test the null hypothesis. The analysis consisted of two different regression analyses. The first analysis consisted of regressing the teachers' sex (TSEX), students' sex (SSEX) and the interaction term (teachers' sex X students' sex) (INTSEX) with the CIS postsurvey scores of the eighth grade students. The second analysis included the same variables listed above but also included the student presurvey scores as a covariate. The purpose of entering the presurvey score in this regression analysis was to remove from this analysis the amount of S/E career interest the students had at the beginning of the year (before the treatment occurred).

Table 3 represents the correlation matrix generated by the SPSS Program in which each variable is correlated with each of the other variables. It is important to point out the statistically significant correlation of .78 ($p < .05$) between the presurvey and postsurvey scores. Also, the correlation coefficients between student sex and both the CIS presurvey scores ($r = -.28$) and postsurvey scores ($r = -.26$) are statistically significant($p < .05$).

The negative correlation here indicates that boys generally had higher scores on the CIS than did girls. None of the other correlation coefficients were statistically significant.

Insert Table 3 about here

Table 4 is the multiple linear regression summary table for the interaction of the sex of the teacher (TSEX) and the sex of the student (SSEX), with CISPOST as the dependent variable. This regression analysis included the CIS postsurvey as the dependent variable and TSEX, SSEX and INTSEX as independent variables. The degrees of freedom were determined by using the number of teacher/student groups. For example, for Teacher 1, the girl students were considered as one case, while, for the same teacher, the boys were considered as another case (refer to Table 1). Therefore, thirty teachers times two groups for each teacher (one representing girls and the other boys) equals sixty teaching units for an n of 60.

Insert Table 4 about here

The important aspect of Table 4 is that the interaction term, INTSEX, did not account for a statistically significant amount of the variance of the dependent variable ($F = .00$, $p > .05$). In testing the amount of variance of the dependent variable accounted for by the interaction variable, the F ratio of the semipartial r-squared was used. The semipartial r squared (sr squared) is the unique amount of the variance of the dependent variable that is accounted for by the particular independent variable when all previous variables are entered into the regression analysis. Since the amount of variance accounted for by the interaction variable was not significant, the null hypothesis could not be rejected.

In Table 5, the second multiple linear regression analysis summary table is given. In this particular analysis, there was one variation from the analysis indicated in Table 4, in that the presurvey scores were entered as a covariate. It can be seen that the presurvey scores accounted for approximately 60% of the variance of the posttest scores, indicating a strong relationship between pre- and postsurvey scores of the students involved. When the CIS presurvey scores are entered into the regression analysis, to statistically control for the initial S/E career interest, the interaction term, INTSEX, again did not account for a statistically significant amount of the variance of the CIS postsurvey scores ($F = .00$, $p > .05$).

Insert Table 5 about here

The correlation between the boys' and girls' presurvey and postsurvey scores on the CIS was .78, which was statistically significant ($p < .05$). The amount of variance (R-squared = .60) of

the postsurvey accounted for by the presurvey was statistically significant ($F = 88.5$, $p < .05$).

In the analysis, the girls' mean CIS postsurvey score was adjusted for initial interest by using the girls' CIS presurvey scores. This was done for the teacher sex variable dichotomy, following the technique described by Cohen & Cohen (1975). The adjusted means, for girls who had a male science teacher and those with a female science teacher, were 15.6 and 16.0, respectively. The small difference between these calculated means reflect the nonsignificant F-ratio reported in Table 5.

Principal Findings

The two main objectives of this study were: (a) to determine whether the interaction of the sex of eighth grade science teachers and the sex of eighth grade students was related to the S/E career interests of eighth grade students, (b) to determine whether the S/E career interest levels of eighth grade girls were enhanced by the presence of a female science teacher, who was acting as a sex-role model.

The results of the statistical treatment of the data indicated that the sex interaction term (INTSEX) did not account for a statistically significant amount of the S/E career interest of eighth grade male or female students. Therefore, the authors were unable to reject the null hypothesis. For the eighth grade students in this study, the findings indicated that the eighth grade science teachers' sex did not systematically influence either the girls' or boys' S/E career interest. Therefore, the teachers were not measured to be acting as significant sex-role models for student S/E career interest.

It is important to point out that in all of the analyses, the covariate CIS presurvey scores accounted for a statistically significant amount of the variance of the CIS postsurvey scores. This indicated that the S/E career interests of the eighth grade students were relatively stable over the eight month period.

In both the CIS postsurvey and presurvey results, eighth grade boys demonstrated significantly stronger S/E career interests than those of eighth grade girls. When the CIS postsurvey scores of the eighth grade girls were adjusted for the CIS presurvey scores, the differences between the scores of the girls who had a male teacher versus those who had a female teacher were not found to be significantly different. Therefore, the change in S/E career interest for both boys and girls over the eight month study period was basically the same.

Discussion and Conclusions

Several previous researchers have reported that the role of science teachers in influencing girls S/E careers as very important (Button & Brown, 1980; O'Leary, 1974; Stake & Granger, 1978; Tidball, cited in "Women in Science, 1975; Trotter, 1976). In questionnaires administered to precollege science students, it has been demonstrated that students generally rated high school science teachers and junior high science teachers as being the first and second most important influences to their S/E career interest

(Koelsche, 1965; Lindsay, 1973; Wright & Hounshell, 1981). The results of the present study are not consistent with the general findings of these researchers. The findings, of the present study, indicate that over the eight month period, the science teachers did not have a significant influence on the S/E career interests of their students.

Stake and Granger (1978) concluded that when the sex of the science teacher and science student were the same, there was a greater science career commitment than when the sexes were different. They reported that there was a statistically significant interaction between student and teacher sex, with teachers acting as sex role models for their students. It should be pointed out that the results, of the present study are not in agreement with Stake and Granger (1978) and this disagreement may be due to the fact that the sample consisted of all eighth grade students, while Stake and Granger were working with high school students who had already expressed an interest in science. It has also been reported by Weiss (1977, cited in Buccino, 1980) that, in grades 7-9, only 33% of the science teachers are women. Because of the small number of women science teachers as compared to men, it has been hypothesized by a number of researchers that the low number of women entering S/E careers is due to the absence of adequate numbers of women science teachers as role models for girls (Button & Brown, 1980; Joesting & Joesting, 1972; Stake & Granger, 1978). The results of this study indicate that, for eighth grade students over an eight month period, there is no interaction between the students' sex and teachers' sex in reference to S/E career interest. It should be noted that this study occurred in an area where the numbers of men and women science teachers are about equal (Schlessinger et al.,1973).

The findings of this study are in agreement with four previous studies which have reported (for fifth and sixth grade, junior high school, high school and college level students) that the teacher did not significantly affect the science interest or science career interests of their students (Lindsay, 1973; Reed, 1961; Vockell & Lobonc, 1981; Weishuar et al.,1981).

It has been reported by several researchers that the S/E career interests of boys at the secondary school level are significantly higher than those of girls at the same level (Hardin & Dede, 1973; Stake & Granger, 1978; Wright & Hounshell, 1981). These conclusions are supported by this research in which it was found that boys had a mean score of 21 on the CIS as compared to a mean score of 16 for girls and that this difference was statistically significant.

Lantz and West (1977), reviewed a number of National Science Foundation programs funded to increase the number of girls going into S/E careers, and recommended that a longer contact period between role models and students should be used in programs of this type. They suggested that the reason the programs did not detect significant changes in the girls' career interests was because of the short contact time in the programs, which were usually a few days to a few weeks.

In the present study, the period of contact was over an eight month period, with each student having contact with the science teacher daily for 45-50 minutes. Even with this extended contact time, the teacher had little influence on the S/E career interests of their students. It is the opinion of the authors that the

inability of the NSF programs to observe S/E career interest changes was due to two problems. These problems involved the absence of a valid and reliable instrument which measures S/E career interest, and a too short contact period between girls and women scientists during the programs. For this study, the instrument developed was shown to be both valid and reliable. The use of this instrument should have solved the problem of accurately measuring S/E career interests. This study also used a contact period of almost a full school year, which should have solved the problem of insufficient contact time between students and scientists. In talking to a number of the eighth grade science teachers involved in this study, it was discovered that they thought of themselves as teachers and not as practicing scientists. Since the science teachers involved in this study appeared to be not as strongly oriented to science as a practicing scientist would be, they may not have been strong enough role-models for science and engineering careers.

It should be noted that only one science teacher of the 30 involved was observed by the authors, during the year, to spend any time on science careers in his/her classroom teaching. Hasan (1975) concluded that, if career interest is a desired end product of a science program, science career-related activities and vocational programs are necessary. If science teachers were not observed spending classtime teaching science career education, it may mean that they do not feel that science career education is an important objective of their science teaching.

In this study, it was discovered that the S/E career interests of the eighth grade students was quite stable over the eight month period of the study. This is in agreement with other studies involving secondary school students. These studies have reported only a 21%-30% change in career interest from 9th to 12th grade (Hansen & Stocco, 1980; Wynn, 1963). These results may indicate that S/E career interests of students are formed earlier than 8th grade and that future studies should investigate when student S/E career interests are formed.

In conclusion, there must be other more important factors that are involved in influencing girls' S/E career interests than those measured in this study. These results suggest that the influence of the sex of one science teacher over one school year is indeed very small, as compared to all of the other school and societal influences which a girl or boy will face before she/he finally decides upon a career.

Recommendations for Future Research

It has been suggested by Lantz and West (1977) that programs and studies involved in factors influencing women S/E career interests should deal only with those students who are already interested in S/E careers. It might be of value to look at the science teacher influence on the S/E interests of those students already interested. Since, in this study, the S/E career interests of the girls were relatively stable over the entire school year, the results suggest that a long term study is needed to get a better idea of when S/E career interests of girls and boys are actually established and what are the major influences. This, of course, would require a study which would follow a group of students through

their school years until they finally become employed.

Since the science teacher may not be as effective a role model for S/E careers as practicing scientists and engineers, a study of how best to train science teachers to be better role models for S/E careers may be necessary.

This study has indicated that when teachers do what they normally do in the science classroom, they do not influence the S/E career interests of the girls or boys in their classes. An experimental study which includes both male and female teachers and students, and in which a weekly S/E career education program was incorporated into the experimental classes and no program into the control classes, might help to demonstrate whether science teachers could be a significant influence in students' S/E career interests.

It has been suggested that the degrees of interest for boys and girls are similar for the biological sciences but are different in the physical sciences and engineering areas. This may suggest that student career interest in the physical sciences and engineering and in the biological sciences may need to be investigated separately (Vockell & Lobonc, 1981; Wright & Hounshell, 1981).

In the 1981 Project Synthesis Report for Science Education, Dr. Norris Harms has stated that:

> The primary teacher characteristics associated with career-choice goal are awareness of the importance of educational and career planning for students' futures and a sense of responsibility for input into career-related decisions. A teacher with these attitudes will naturally keep abreast of the science-related job market, be aware of sources of career information and community resources, and pass this information on to students as a natural and normal part of science classes. The aware teacher will find many opportunities to discuss specific careers associated with specific topics in science and science-related societal issues. (Harms & Yager, 1981, p.124)

The above statement by Harms, in light of the present study, suggests that it might be time for science teachers to reevaluate the objectives of their science programs and determine if they are meeting the science and engineering career needs of all their students.

Acknowledgments

The authors would like to acknowledge Sigma Xi, The Scientific Research Society, for their generous Grant-in-Aid in support of this research; the students, teachers, and administrators of the Brevard and Indian River County School Systems (Florida), and the Interactive Computing Facility at Florida Institute of Technology for helping to make this research possible.

Reference Notes

1. Murray, D. Personal communication, Science Resource Teacher, Brevard County School System, Rockledge, FL., August, 1981.

2. Murray, D. Personal communication, Science Resource Teacher, Brevard County School System, Rockledge, FL., September, 1981.

3. Schmidt, L. Personal communication, Career Education Coordinator, Brevard County School System, Merritt Island, FL., September, 1981.

References

American Institutes for Research. Interest inventory, PCG, planning career goals. Monterey, California: CTB/McGraw-Hill. 1975.

Bray, J. H., & Howard, G. S. Interaction of teacher and student sex and sex role orientations and student evaluations of college instruction. Contemporary Educational Psychology, 1980, 5, 241-248.

Brown, G. H. Degree awards to women: An update. National Center for Educational Statistics, Washington, D.C.: U.S. Dept. of HEW, 1979.

Buccino, A. (Dir.). Science education databook (National Science Foundation Publication SE 80-3). Washington, D.C.: U.S. Government Printing Office, 1980.

Button, L., & Brown, R. A. Women in science. School Science and Mathematics, 1980, 80(3), 206-210.

Cohen, J., & Cohen, P. Applied multiple regression/correlation analysis for the behavioral sciences. New York: John Wiley & Sons, 1975.

Cutler, A., Ferry, F., Kauk, R., & Robinett, R. JOB-O (fifth printing). Belmont, California: CFKR Career Materials Inc., 1980.

Hansen, J. C., & Stocco, J. E. Stability of vocational interests of adolescents and young adults. Measurement and Evaluation in Guidance, 1980, 13(3), 173-178.

Hardin, J., & Dede, D. Discrimination against women in science education. Science Teacher, 1973, 40(9), 18-21.

Harms, N. C., & Yager, R. E. What research says to the science teacher (Vol. 3). Washington, D.C.: NSTA, 1981.

Hasan, O. E. An investigation into factors affecting science interest of secondary school students. Journal of Research in Science Teaching, 1975, 12(3), 255-261.

Holland, J. L. The self directed search form E for educational and vocational planning. Palo Alto, California: Consulting Psychologists Press, 1979.

Joesting, J., & Joesting, R. Sex differences in group belongingness as influenced by instructor's sex. Psychological Reports, 1972, 31, 717-718.

Kemper, T. Reference groups, socialization and achievement. American Sociological Review, 1968, 33, 31-45.

Koelsch, C.L. Characteristics of potential scientists. Science Education, 1965, 49(1), 72-79.

Kornberg, W. (Ed.). Women scientists and engineers improve employment position between 1976 and 1978. Mosaic, 1980, 11(3), 46.

Kuder, G. F. Kuder E general interest survey. Chicago: Science Research Associates, Inc., 1976.

LaFitte, P. C. Work values of university students: An analysis by ethnic groups and sex. 1974. (ERIC Document Reproduction Service No. ED 144 849)

Lantz, A., & West, A. S. An impact analysis of sponsored projects to increase the participation of women in careers in science and technology (abbreviated version). Denver, Colo.: University of Colorado Research Institute, 1977. (ERIC Document Reproduction Service No. ED 151 202)

Lindsay, N. S. The impact of sex role stereotypes as reflected in interests in science in the elementary grades (Doctoral dissertation, Harvard University, 1973). Dissertation Abstracts International, 1973, 34/11-A, 704B.

Maccoby, E., & Wilson, W. Identification and observational learning from films. Journal of Abnormal and Social Psychology, 1957, 55, 76-87.

Malcom, S. M., Hall, P. Q., & Brown, J. W. The double bind: The price of being a minority woman in science. Washington, D. C.: American Association for the Advancement of Science, 1976. (ERIC Document Reproduction Service No. ED 130 851)

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., & Bent, D. H. Statistical package for the social sciences. New York: McGraw-Hill, 1975.

O'Leary, V. E. Some attitudinal barriers to occupational aspirations in women. Psychological Bulletin, 1974, 81(11), 809-826.

Reed, H. B. Jr. Teacher variables of warmth, demand and utilization of intrinsic motivation related to pupils' science interests: A study illustrating several potentials of variance-covariance. Journal of Experimental Education, 1961, 29(3), 205-229.

Remick, H., & Miller, K. Participation rates in high school mathematics and science courses. 1977. (ERIC Document Reproduction Service No. ED 160 411)

Schlessinger, F. R., Howe, R. W., White, A. L., Chin, L. F., Baker, J. H., & Buckeridge, E. C. A survey of science teaching in public schools of the United States (1971), Volume 1-Secondary Schools. Columbus, Ohio: ERIC/SMEAC, 1973.

Sears, P. S., & Feldman, D. H. Teacher interaction with boys and with girls. National Elementary Principal, 1966, 46(2), 30-35.

Shein, V. Fair employment of women through personnel research. Personnel Journal, 1972, 51, 330-335.

Stake, J. E., & Granger, C. R. Same-sex and opposite-sex teacher model influences on science career commitment among high school students. Journal of Educational Psychology, 1978, 70(2), 180-186.

Trotter, V. Y. The future for women in science and engineering. 1976. (ERIC Document Reproduction Service No. ED 133 205)

Vockell, E. L., & Lobonc, S. Sex-role stereotyping by high school females in science. Journal of Research in Science Teaching, 1981, 18(3), 209-219.

Weishaar, M. E., Green, B. J., & Craighead, L. W. Primary influencers of initial vocational choice for college women. Journal of Vocational Behavior, 1981, 18, 67-78.

Weiss, I. R., Place, C., & Conaway, L. E. The visiting women scientists pilot program 1978: Highlights report. Durham, N.C.: Research Triangle Institute, 1978. (ERIC Document Reproduction Service No. ED 164 290)

Women and minorities in science and engineering (National Science Foundation Publications NSF 77-304). Washington, D.C.: U.S. Government Printing Office, 1977.

Women in science. Mosaic, 1975, 6(6), 8-13.

Wright, J. D., & Hounshell, P. B. A survey of interest in science for participants in a junior science and humanities symposium. School Science and Mathematics, 1981, 81(5), 378-382.

Wynn, D. C. Factors related to gain and loss of scientific interest during high school (Doctoral dissertation, University of Georgia, 1963). Dissertation Abstracts International, 1963, 24/11, 4491.

Table 1

CIS Presurvey and Postsurvey Means for Eighth Grade Girls and Boys of Each Science Teacher, Including Number of Students and Teacher Sex

	Girls			Boys			
Teacher	Mean CISPRE	Mean CISPOST	N	Mean CISPRE	Mean CISPOST	N	SEX
1	13.67	13.70	33	17.84	17.53	32	M
2	13.40	6.40	5	17.14	14.55	22	F
3	20.25	17.25	4	15.00	19.50	6	M
4	16.22	16.61	51	23.59	23.41	34	F
5	14.38	14.50	8	20.50	19.25	8	M
6	12.59	12.13	39	19.73	19.93	44	M
7	19.91	19.55	56	23.68	23.76	50	M
8	15.48	13.67	21	23.45	21.17	29	M
9	15.24	15.48	42	20.43	19.74	47	M
10	16.22	16.10	72	23.30	22.41	46	F
11	15.73	15.60	15	20.08	19.17	12	M
12	15.44	15.06	50	21.78	20.27	51	F
13	14.18	15.09	11	21.25	19.67	12	F
14	15.42	14.80	59	24.06	23.32	47	M
15	17.53	19.20	15	18.85	16.35	20	M
16	15.50	14.19	16	20.38	18.50	24	F
17	17.43	15.78	49	21.09	18.69	45	F
18	15.75	14.70	40	24.06	22.29	31	F
19	16.61	15.06	18	26.18	23.55	11	F
20	14.21	12.57	14	20.92	19.58	12	M
21	19.12	18.71	34	23.22	20.52	27	F
22	11.33	4.67	6	16.43	13.57	7	F
23	17.56	16.59	54	22.47	21.53	74	M
24	18.06	17.08	64	20.60	20.49	45	F
25	18.60	21.90	10	23.73	23.82	11	M
26	16.00	17.86	7	17.64	18.73	22	F
27	14.90	13.83	42	21.90	18.79	39	F
28	12.61	10.61	18	18.23	16.33	30	F
29	17.88	16.82	67	22.41	20.12	51	M
30	17.97	16.76	72	25.84	25.79	56	F

KEY
N - Number of Students
SEX - M = Male, F = Female

Table 2

CIS Mean Scores, Standard Deviation and Sample Size

For Eighth Grade Boys and Girls

Students	Survey Time	Mean	Standard Deviation	N of Cases
All	CISPRE	19.0	9.5	1937
	CISPOST	18.1	9.3	1937
Girls	CISPRE	16.4	9.2	992
Only	CISPOST	15.8	9.0	992
Boys	CISPRE	21.8	9.0	945
Only	CISPOST	20.7	8.9	945

Table 3

Correlation Matrix for Student CIS Scores, Teacher Sex, Student Sex and an Interaction Variable

Variable	CISPOST	CISPRE	TSEX	SSEX	INTSEX
CISPOST	1.000				
CISPRE	.777*	1.000			
TSEX	-.022	.002	1.000		
SSEX	-.263*	-.280*	.028	1.000	
INTSEX	-.025	-.030	.022	.091	1.000

*$p < .05$

Table 4

Multiple Linear Regression Analysis Summary Table

With CISPOST as the Dependent Variable

Variable	Multiple R	R Square	RSQ Change	Simple R	DF	F Ratio[a]
TSEX	.022	.000	.000	-.022	-	-
SSEX	.263	.069	.069	-.263	-	-
INTSEX	.263	.069	.000	-.025	3,56	.00

[a]For sr^2

Table 5

Multiple Linear Regression Analysis Summary Table

With CISPOST as the Dependent Variable

and CISPRE as a Covariate

Variable	Multiple R	R Square	RSQ Change	Simple R	DF	F Ratio[a]
CISPRE	.777	.604	.604	.777	1,58	88.5*
TSEX	.777	.604	.000	-.022	-	-
SSEX	.779	.606	.002	-.263	-	-
INTSEX	.779	.606	.000	-.025	4,55	.00

[a]For sr^2

*$p < .05$